(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 514 947 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
24.10.2012 Bulletin 2012/43

(21) Application number: **12171771.4**

(22) Date of filing: **31.03.2009**

(51) Int Cl.:
F02C 7/047 *(2006.01)* ***F01D 21/04*** *(2006.01)*
F02C 7/05 *(2006.01)*

(84) Designated Contracting States:
DE GB

(30) Priority: **30.05.2008 US 129990**

(62) Document number(s) of the earlier application(s) in accordance with Art. 76 EPC:
09251017.1 / 2 128 402

(71) Applicant: **United Technologies Corporation**
Hartford, CT 06101 (US)

(72) Inventor: **Cloft, Thomas G.**
Glastonbury, CT Connecticut 06033 (US)

(74) Representative: **Leckey, David Herbert**
Dehns
10 Salisbury Square
London
Greater London EC4Y 8JD (GB)

Remarks:
This application was filed on 13-06-2012 as a divisional application to the application mentioned under INID code 62.

(54) Gas turbine engine including a nacelle assembly which comprises a cavity and a fan containment case

(57) A gas turbine engine (10) comprises a nacelle assembly (25), a core engine (25) at least partially surrounded by the nacelle assembly (35) and including a fan section (14), a compressor section (16), a combustor section (22) and a turbine section (24) and a fan containment case (38) positioned annularly about the fan section (14). The engine also includes a cavity (64) annularly extending radially between the fan containment case (38) and the nacelle assembly (35), the cavity (64) extending upstream from the fan section (14) and mountably receiving an engine accessory (66).

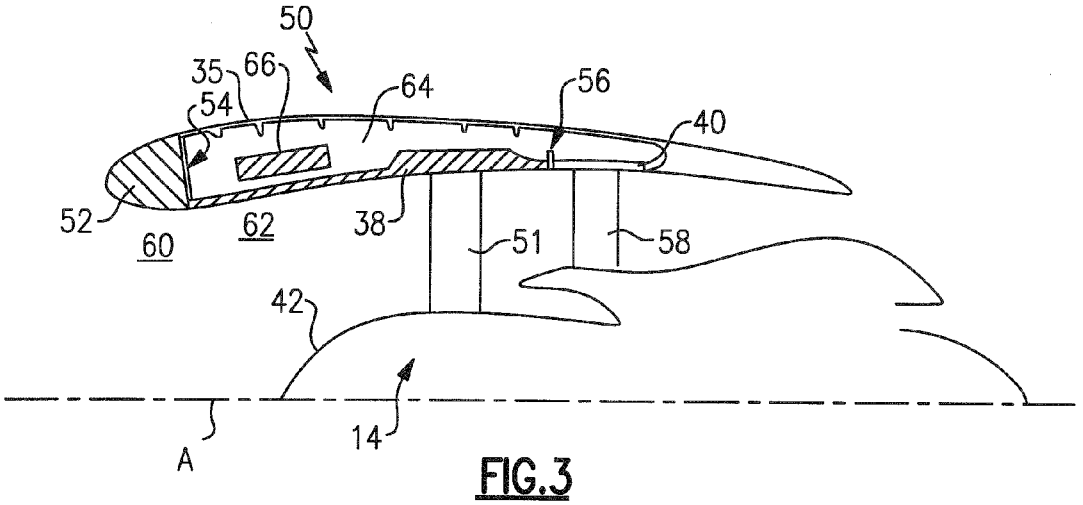

FIG.3

EP 2 514 947 A1

Description

BACKGROUND OF THE INVENTION

[0001] This disclosure relates generally to a gas turbine engine, and more particularly to a gas turbine engine assembly including a relocated front flange.

[0002] Gas turbine engines, such as turbofan gas turbine engines, typically include a core engine having a fan section, a compressor section, a combustor section and a turbine section. During operation, air is pressurized in the compressor section and mixed with fuel in the combustor section for generating hot combustion gases. The hot combustion gases flow through the turbine section which extracts energy from the hot combustion gases to power the compressor section and drive the fan section.

[0003] The core engine includes an engine casing structure that includes a fan containment case (FCC) and a fan case downstream from the FCC. The FCC and the fan case surround the fan section of the gas turbine engine and contain the fan section components in the event of a fan blade out event. A fan blade out event occurs where a fan blade of the fan section becomes dislodged from the fan section and strikes the FCC.

[0004] The core engine is generally surrounded by a nacelle assembly that is annularly disposed about the core engine. The nacelle assembly and the engine casing structure cooperate to assemble the gas turbine engine. Typically, an inlet lip assembly of the nacelle assembly is attached to an A-flange disposed about the fan section of the core engine. The FCC is attached to an opposite side of the A-flange from the inlet lip assembly. The A-flange permits assembly/disassembly of the inlet lip assembly from the FCC. A B-flange is typically positioned downstream from the A-flange and permits assembly/disassembly of the FCC from the fan case.

[0005] The current location of the A-flange about the fan section necessitates that the inlet lip assembly include forward and aft bulkheads. The bulkheads provide radial stiffness and support to the inlet lip assembly. The bulkheads add additional weight and expense to the gas turbine engine assembly, and may negatively affect gas turbine engine efficiency and fuel consumption.

[0006] In addition, an engine electronic control is typically mounted aft of the fan containment case, such as on the fan case. The fan case provides a relatively cool mounting environment that is readily accessible for maintenance through fan cowl doors positioned on the nacelle assembly. Disadvantageously, modern gas turbine engines include engine electronic controls of increased size, and include a reduced amount of mounting space aft of the FCC. Therefore, modern gas turbine engines are becoming more difficult and expensive to assemble.

[0007] Accordingly, it is desirable to provide a gas turbine engine assembly that is of reduced weight, reduced complexity, and that may be assembled at a reduced cost.

SUMMARY OF THE INVENTION

[0008] A gas turbine engine assembly according to a first aspect of the invention includes an inlet lip assembly, a fan containment case, and a front flange. The fan containment case surrounds a fan section and is positioned downstream from the inlet lip assembly. The front flange is mounted between the inlet lip assembly and the fan containment case and is positioned upstream from the fan section.

[0009] A method of assembling a gas turbine engine according to a further aspect of the invention includes positioning a front flange upstream from a fan section of the gas turbine engine, mounting an inlet lip assembly to a first side of the front flange, and mounting a fan containment case to a second side of the front flange.

[0010] A gas turbine engine according to a yet further aspect of the invention includes a nacelle assembly, a core engine, a fan containment case and a cavity. The core engine is partially surrounded by the nacelle assembly and includes a fan section, a compressor section, a combustor section, and a turbine section. The fan containment case is positioned about the fan section. The cavity annularly extends between the nacelle assembly and the fan containment case. The cavity extends upstream from the fan section and mountably receives an engine accessory.

[0011] The various features and advantages of this disclosure will become apparent to those skilled in the art from the following detailed description. The drawings that accompany the detailed description can be briefly described as follows.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012]

Figure 1 illustrates a general perspective view of a gas turbine engine;

Figure 2 illustrates a partial sectional view of an example gas turbine engine having an engine casing structure on the lower half thereof;

Figure 3 illustrates a cross-sectional view of an example gas turbine engine assembly; and

Figure 4 illustrates the example gas turbine engine assembly illustrated in Figure 3 including a cavity for housing an engine accessory.

DETAILED DESCRIPTION OF THE EXAMPLE EMBODIMENT

[0013] Figure 1 illustrates a gas turbine engine 10 suspended from an engine pylon 12 as is typical of an aircraft designed for subsonic operation. In one example, the gas turbine engine 10 is a turbofan gas turbine engine. The gas turbine engine 10 includes a core engine 25. The core engine 25 includes a fan section 14, a compressor section 16 having a low pressure compressor 18

and a high pressure compressor 20, a combustor section 22, and a turbine section 24 having a high pressure turbine 26 and a low pressure turbine 28. A low speed shaft 30 rotationally supports the low pressure compressor 18 and the low pressure turbine 28. The low speed shaft 30 also drives the fan section 14 either directly, or through a gear train 34, for example. A high speed shaft 32 rotationally supports the high pressure compressor 20 and the high pressure turbine 26. The low speed shaft 30 and the high speed shaft 32 rotate about a longitudinal centerline axis A of the gas turbine engine 10.

[0014] During operation, airflow is drawn into the gas turbine engine 10 by the fan section 14 and is pressurized in the compressor section 16. Fuel is mixed with pressurized air and combusted within the combustor section 22. The combustion gases are discharged through the turbine section 24 which extracts energy therefrom for powering the compressor section 16 and the fan section 14.

[0015] A nacelle assembly 35 at least partially surrounds the core engine 25. The nacelle assembly 35 protects the core engine 25 and provides a smooth flow surface for incoming airflow. The nacelle assembly 35 includes an inlet lip assembly 52 (See Figure 4) having a contoured profile for directing airflow to the fan section 14.

[0016] Of course, this view is highly schematic. It should be understood that the features and example illustrations presented herein are not limited to a turbofan gas turbine engine. That is, the present disclosure is applicable to any engine architecture.

[0017] Figure 2 illustrates an engine casing structure 36 of the example gas turbine engine 10. The engine casing structure 36 includes a fan containment case (FCC) 38 and a fan case 40. The fan case 40 is positioned downstream from the FCC 38. The FCC 38 and the fan case 40 surround the fan section 14 and protect the gas turbine engine 10 from damage that may be caused during certain flight events, such as a fan blade out event. A fan blade out event occurs where a fan blade 51 of the fan section 14 becomes dislodged from the fan section 14 and strikes the FCC 38. It should be understood that the engine casing structure 36 would include numerous other case sections.

[0018] In this example, the FCC 38 extends upstream from the fan section 14. In another example, at least a portion of the FCC 38 extends upstream from a nose cone 42 of the fan section 14. That is, the example FCC 38 extends both forward and aft of the fan section 14.

[0019] Figure 3 illustrates an example gas turbine engine assembly 50. The gas turbine engine assembly 50 includes an inlet lip assembly 52, the fan containment case 38, a front flange 54, and a rear flange 56. In one example, the front flange 54 represents the A-flange of the gas turbine engine 10, and the rear flange 56 represents the B-flange of the gas turbine engine 10. In another example, the front flange 54 and the rear flange 56 are axial flanges. The front flange 54 is positioned entirely upstream from the fan section 14. In one example, the front flange 54 is positioned upstream from the nose cone 42. In yet another example, the rear flange 56 is positioned between the fan section 14 and a fan exit guide vane 58.

[0020] Repositioning the front flange 54 at a position upstream from the fan section 14 provides an extended fan containment case 38 as compared to prior art gas turbine engines that include a front flange 54 positioned directly adjacent to a fan section 14. The inlet lip assembly 52 is attached to the front flange 54 on an upstream side 60 of the front flange 54. The fan containment case 38 is attached to a downstream side 62 of the front flange 54. In one example, the inlet lip assembly 52 and the FCC 38 are bolted to the front flange 54. The front flange 54 permits assembly/disassembly of the inlet lip assembly 52 from the fan containment case 38. That is, the inlet lip assembly 52 is removable from the gas turbine engine assembly 50.

[0021] The inlet lip assembly 52 may include a plurality of advanced technology devices. For example, the inlet lip assembly 52 includes an electrical de-ice system.

[0022] The fan containment case 38 extends between the front flange 54 and the rear flange 56. The fan containment case 38 is assembled/disassembled from the fan case 40 at the rear flange 56. That is, the gas turbine engine assembly 50 may be assembled/disassembled at two points - the front flange 54 and the rear flange 56. No other bulkheads or radial stiffeners are required. Therefore, the gas turbine engine assembly 50 provides significant weight reductions for the gas turbine engine 10.

[0023] Figure 4 illustrates a cavity 64 that annularly extends between the nacelle assembly 35 and the FCC 38. In one example, the cavity 64 extends from the front flange 54 to the rear flange 56. In another example, the cavity 64 extends from a position forward of the front flange 54 to a position downstream of the fan exit guide vane 58 (See Figure 3). It should be understood that the cavity 64 shown in Figure 4 is illustrated enlarged to better illustrate its design and function. A worker of ordinary skill in the art would be able to select an appropriate size, volume etc. for the cavity 64.

[0024] The cavity 64 provides an additional volume for mounting an engine accessory 66. The increased volume is a direct result of the repositioning of the front flange 54 upstream from the fan section 14 and removal of bulkheads and radial stiffeners between the front flange 54 and the rear flange 56. In one example, the engine accessory 66 is an engine electronic control (EEC). It should be understood that other engine accessories may be mounted within the cavity 64. The nacelle assembly includes a door 68 that may be opened and closed to provide access to the engine accessory 66.

[0025] Incorporating a removable inlet lip assembly 52 with an extended FCC 38 improves maintainability both on-wing and in-shop for maintenance purposes. Repositioning the front flange 54 upstream from the fan section 14 avoids a weight and cost penalty associated with adding additional assembly flanges. In addition, mounting

the engine accessory 66 within the cavity 64 provides cooler environmental temperatures and lower engine vibration levels that improve the reliability of the engine accessories 66.

[0026] The foregoing description shall be interpreted as illustrative and not in any limiting sense. A worker of ordinary skill in the art would understand that certain modifications would come within the scope of this disclosure. For these reasons, the following claims should be studied to determine the true scope and content of this disclosure.

Claims

1. A gas turbine engine (10), comprising:

a nacelle assembly (25);
a core engine (25) at least partially surrounded by said nacelle assembly (35) and including a fan section (14), a compressor section (16), a combustor section (22) and a turbine section (24);
a fan containment case (38) positioned annularly about said fan section (14);
and
a cavity (64) annularly extending radially between said fan containment case (38) and said nacelle assembly (35), wherein said cavity (64) extends upstream from said fan section (14) and mountably receives an engine accessory (66).

2. The gas turbine engine as recited in claim 1, wherein said nacelle assembly includes an inlet lip assembly (52), and said inlet lip assembly (52) is removably attached upstream of said fan containment case (38).

3. The gas turbine engine as recited in claim 2, comprising a front flange (54) mounted between said inlet lip assembly (52) and said fan containment case (38),

4. The gas turbine engine as recited in claim 3 wherein said cavity extends unobstructed between said front flange (54) and a position aft of a rear flange (56).

5. The gas turbine engine as recited in claim 4 wherein said rear flange (56) is positioned between said fan section (14) and a fan exit guide vane (58).

6. The gas turbine engine as recited in claim 3, 4 or 5 wherein said inlet lip assembly (52) is removably attached to an upstream side of said front flange (54).

7. The gas turbine engine as recited in any of claims 3 to 6, wherein said fan containment case (38) is attached to a downstream side of said front flange (54).

8. The gas turbine engine as recited in any preceding claim wherein said engine accessory (66) includes an engine electronic control.

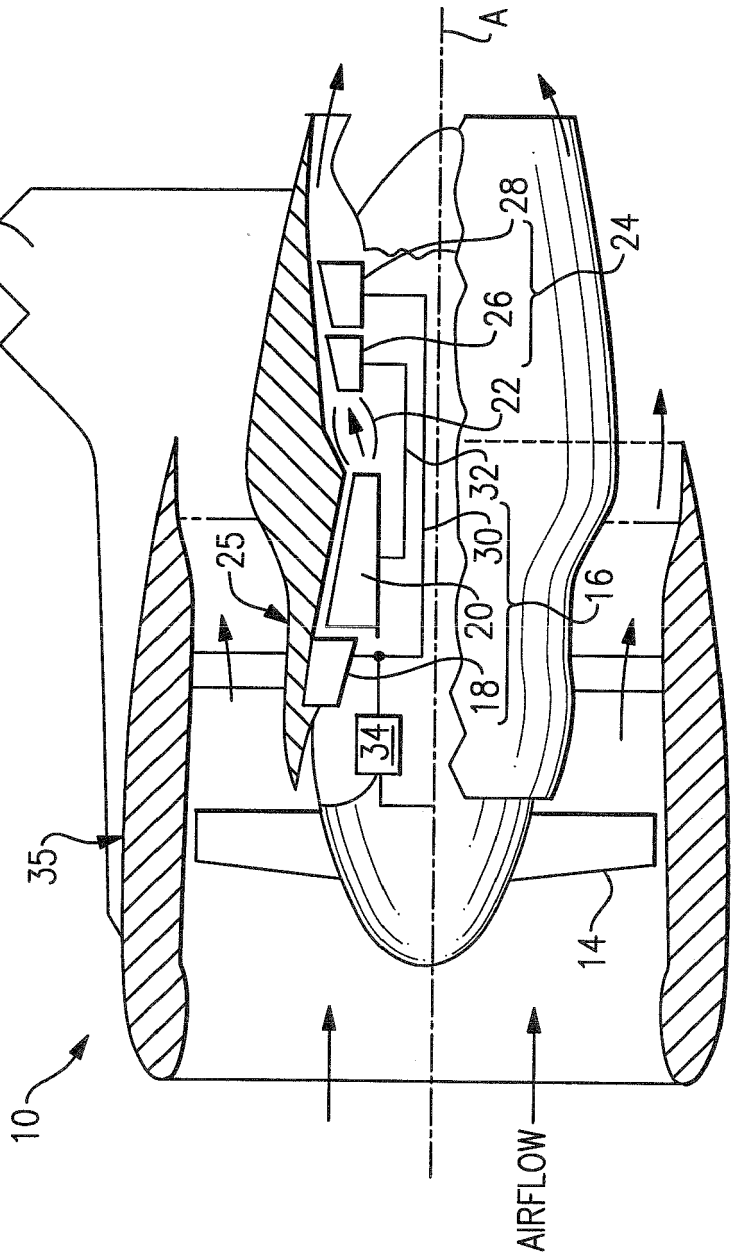

FIG.1

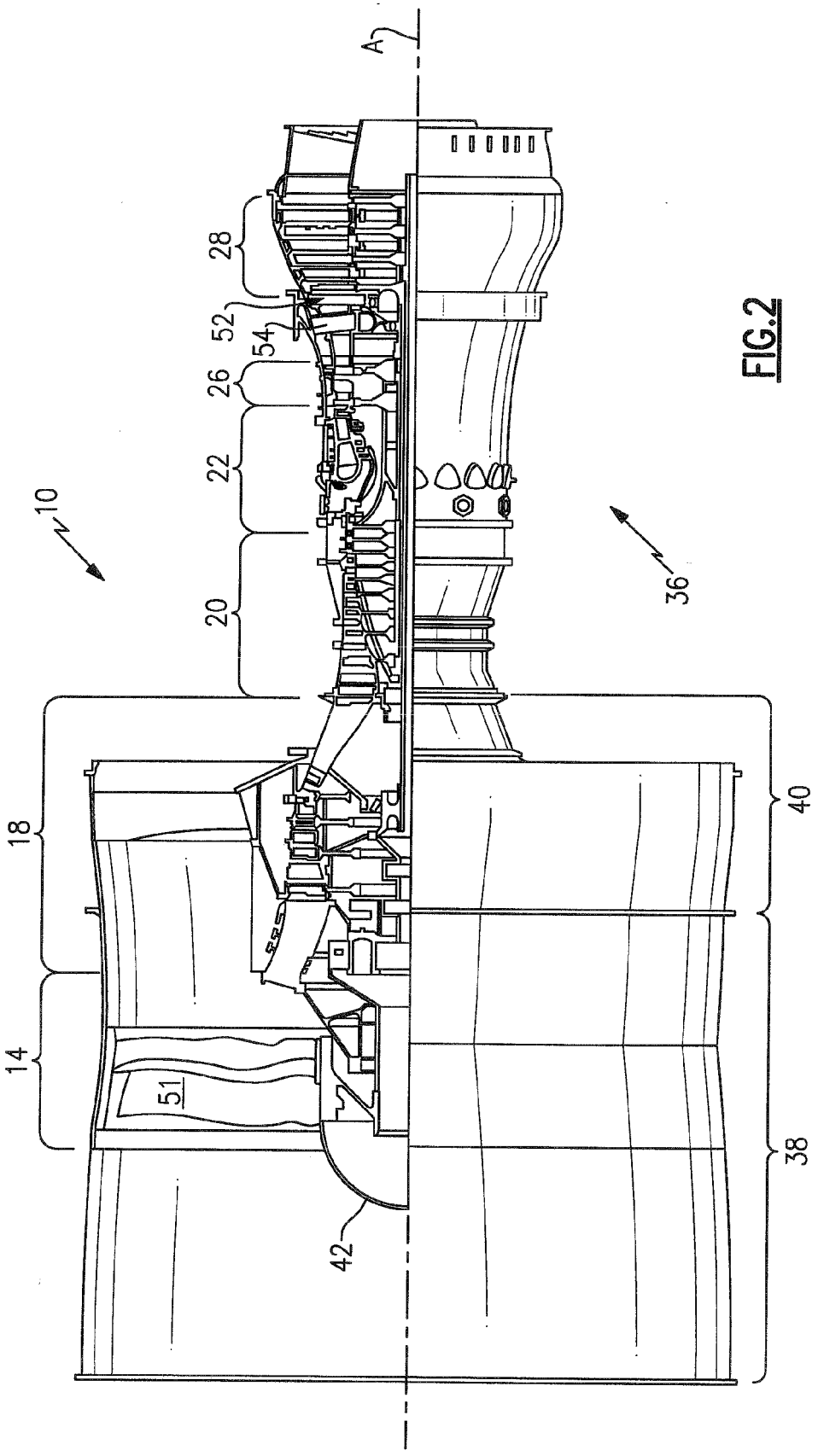

FIG.2

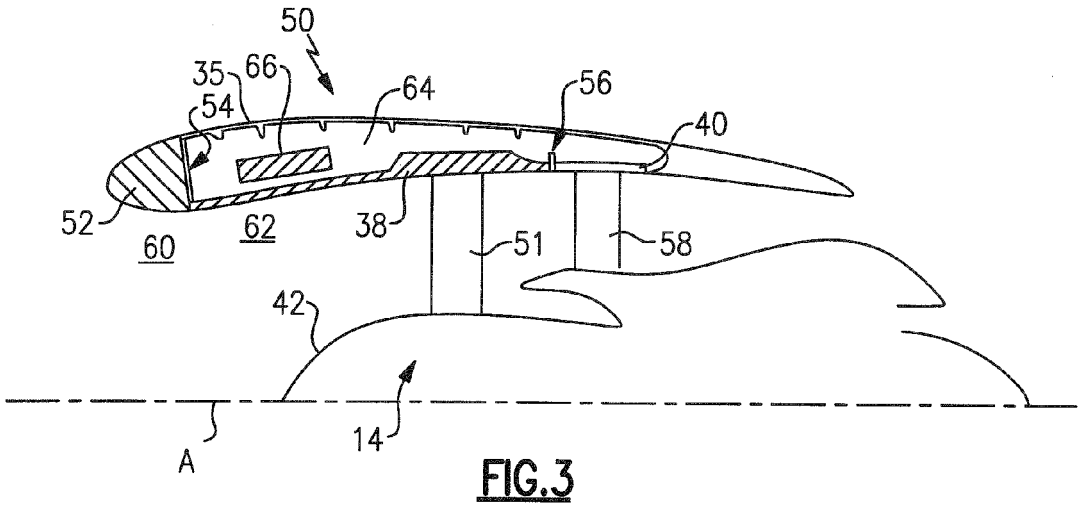

FIG.3

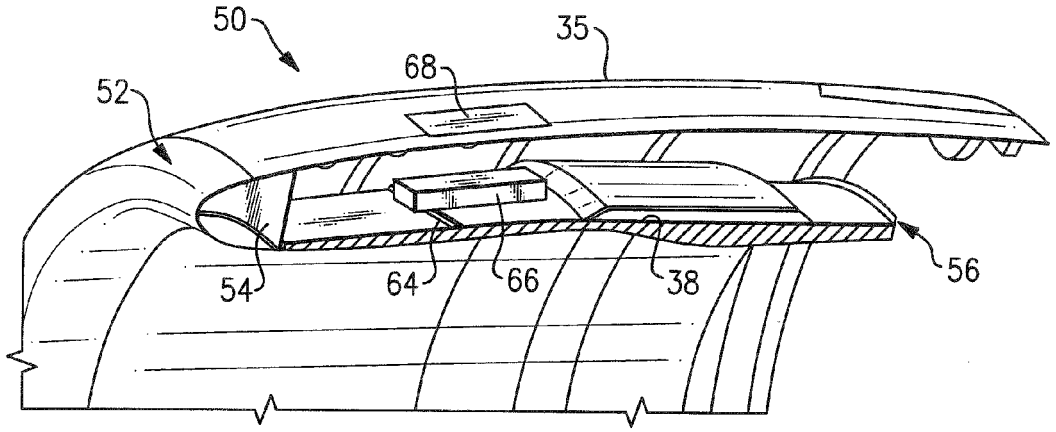

FIG.4

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 12 17 1771

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	FR 2 757 823 A (AEROSPATIALE [FR]) 3 July 1998 (1998-07-03) * page 11, line 25 - page 12, line 2 * * page 14, line 3 - line 15 * * page 17, lines 32,33 * * page 18, lines 19-23 * * page 19, lines 7-11 * * figures 1-3,7,8 * -----	1-8	INV. F02C7/047 F01D21/04 F02C7/05
A	EP 1 336 739 A (GEN ELECTRIC [US]) 20 August 2003 (2003-08-20) * page 3, column 3, paragraphs 9,10 - column 4, paragraphs 13,14 * * figure 1 * -----	1-8	
A	US 2004/094359 A1 (PORTE ALAIN [FR] ET AL) 20 May 2004 (2004-05-20) * page 2, paragraphs 38,40,41 * * page 3, paragraphs 41,43 * * figures 1,5,7 * -----	1-8	
A	EP 1 479 889 A (ROLLS ROYCE PLC [GB]) 24 November 2004 (2004-11-24) * page 3, column 3, paragraph 23 * * page 3, column 4, paragraph 25 * * figure 1 * -----	1-8	TECHNICAL FIELDS SEARCHED (IPC) F02C F02K F01D
A	GB 2 259 679 A (SHORT BROTHERS PLC [GB]) 24 March 1993 (1993-03-24) * page 6, paragraph 6 * * figures 1,4,5 * -----	1-8	
A	EP 1 715 159 A (ROHR INC [US]) 25 October 2006 (2006-10-25) * abstract * * page 3, column 4, paragraph 15 * * page 4, column 6, paragraph 24 * * figures 1-6 * -----	1-8	
	-/--		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	18 September 2012	Klados, Iason

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 12 17 1771

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	GB 2 259 287 A (ROLLS ROYCE PLC [GB]) 10 March 1993 (1993-03-10) * abstract * * page 3, paragraphs 3,4 * * page 4, paragraph 3 * * figures 1,2 * -----	1-8	

TECHNICAL FIELDS SEARCHED (IPC)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	18 September 2012	Klados, Iason

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

1

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 12 17 1771

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

18-09-2012

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
FR 2757823 A	03-07-1998		
EP 1336739 A	20-08-2003	EP 1336739 A2	20-08-2003
		JP 4256177 B2	22-04-2009
		JP 2003269398 A	25-09-2003
		US 2003156940 A1	21-08-2003
US 2004094359 A1	20-05-2004	AT 344876 T	15-11-2006
		CA 2441058 A1	18-05-2004
		DE 60309556 T2	14-06-2007
		EP 1426587 A1	09-06-2004
		ES 2275070 T3	01-06-2007
		FR 2847304 A1	21-05-2004
		US 2004094359 A1	20-05-2004
EP 1479889 A	24-11-2004	DE 602004000889 T2	14-09-2006
		EP 1479889 A2	24-11-2004
		US 2005150204 A1	14-07-2005
GB 2259679 A	24-03-1993	AU 655077 B2	01-12-1994
		AU 2592792 A	27-04-1993
		BR 9205410 A	07-06-1994
		CA 2095530 A1	21-03-1993
		DE 69207889 D1	07-03-1996
		EP 0558726 A1	08-09-1993
		GB 2259679 A	24-03-1993
		IL 103208 A	27-11-1995
		JP H06502825 A	31-03-1994
		US 5400984 A	28-03-1995
		WO 9306005 A1	01-04-1993
EP 1715159 A	25-10-2006	AT 438794 T	15-08-2009
		AT 523674 T	15-09-2011
		EP 1715159 A1	25-10-2006
		EP 2112353 A1	28-10-2009
		US 2006237582 A1	26-10-2006
		US 2009008509 A1	08-01-2009
		US 2009014598 A1	15-01-2009
GB 2259287 A	10-03-1993	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82